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Child language cuts capers

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Chapter 1

Introduction

“Everything changes, that is the one thing we know for sure in this world”¹

For a long time, developmental psychology has emphasized the gradual character of development, which can be defined as “change” or as a “pattern through time”. This gradualness is expressed in the fact that many developmental studies show average growth curves of a group of subjects. However, time serial data sets -i.e. sets of repeated measurements of the same individual through time- show a remarkable lack of smoothness. Recently, there has been an increasing interest in this phenomenon of intra-individual variability, mainly due to dynamic systems theory (Thelen & Smith, 1994; van Geert, 1994). Traditionally, lack of stability and the presence of variability in data are considered to be the result of measurement error or environmental factors. However, dynamic systems theory radically rejects the automatic retreat to the error hypothesis and claims that variability bears important information about the nature of the developmental process. Thus, the theory views variability as an important developmental characteristic and focuses on dynamic properties of change.

A second dynamic property of change is the ambiguity of developing behavior. In the literature, the concept of inter-observer agreement is used to indicate the reliability of a study. However, in practice, reliability is critically dependent of the concept of true behavioral categories that are mutually exclusive and that can be observed without subjective interpretation. The dynamic systems perspective criticizes the use of “crisp” categories for developing behavior. According to Thelen (1997), behavioral categories may impose arbitrary criteria on what is actually continuous behavior. The concept of ambiguous categories is closely related to *Fuzzy Logic*, a mathematical theory that is used to program computers to “make decisions” based on imprecise data and complex situations (McNeill & Freiburger, 1993). In modern fuzzy logic, “objects” (observations, objects, properties, etc.) are always assigned a Degree-of-Membership to a category, set or class (see Ross, 1995; Kosko 1993, 1997; Nguyen & Walker, 1997; von Altrock, 1995; McNeill and Freiburger, 1993). In mutually exhaustive classes, objects have a degree-of-membership of either 1 or 0 (for instance, a word is either a preposition or not a preposition). In fuzzy logic, an object has any degree of membership between 0 and 1. Maximal ambiguity arises if an object has a degree of membership equal to 0.5. In the case of developing behavior a specific act may occupy a mid-point between two observational categories, for instance a word uttered by an infant may take a position between a preposition and (for instance) a verb.

If we agree with dynamic systems theory that both variability and ambiguity are important characteristics of a developing system, there are two central problems. The first problem is that relatively little is known about variability (fluctuations) and ambiguity. The second problem that might be responsible for this lack of knowledge is that there is a lack of technical means –statistical

¹ Source: *Calvin and Hobbes* by Bill Watterson

methods- that can be used to describe and analyze patterns of fluctuation and ambiguity. It is the main goal of this thesis to contribute to a solution to both of these problems.

Since empirical knowledge is critically dependent on the method of study, the first goal is to contribute to the methodology by proposing various simple but powerful techniques for describing and analyzing variability and ambiguity. The aim is to help other researchers focus on rich additional sources of information that are contained in variability as well as in ambiguity. This focus will lead to more interesting hypotheses and more powerful testing procedures, adapted to the unique nature of developmental data. Secondly, an empirical study of variability and ambiguity is conducted in one specific domain of development, namely early language development. This study aims at providing a first description and explanation of variability and ambiguity in this specific field of child development.

Chapter 2 provides a general introduction on intra-individual variability in developmental research and uses the language data from two young children (subjects Jan and Eva, age 2;4 and 2;8) as an illustration of this phenomenon. Short-term variability was studied in Mean Length of Utterance (MLU-m, Brown, 1973), an important language measure. The data of both children showed considerable variability in MLU, even between measurement days. In addition to describing and illustrating variability, the chapter addresses how “noise” can be distinguished from variability that is developmentally meaningful. In this chapter we anticipate on the description of several new techniques that can be used to study the characteristics of variability in typical time serial data of child development.

Chapter 3 elaborates on the methodology of analyzing patterns of variability. In this chapter several new methods that are especially useful for visualizing and describing intra-individual variability in time serial data are described. In order to illustrate these methods, they are applied to data of early language development, to be more specific the development of MLU-w and prepositions (subject Heleen, age 1;6 to 2;6). Finally, as traditional statistical techniques have little to offer in testing variability hypotheses, the possibilities that are provided by random sampling techniques are examined.

The aim of chapter 4 is to present a new approach to the analysis of longitudinal language data (time series), and use it to analyze a dataset of early child speech - in particular data on the development of prepositions and their use across contexts. This chapter claims that a thorough quantitative analysis may contribute to a better understanding both of the qualitative aspects and of the underlying mechanisms of development. The chapter focuses on a quantitative analysis of continuity versus discontinuity and on the form of - and eventual changes in - the variability in the data. The theoretical introduction discusses each of the central issues - quantitative aspects, continuity, discontinuity and variability –separately. So far, these phenomena have hardly been investigated in the study of language acquisition. Dynamic systems theory is referred to as a general theory of change that we use to defend the importance of quantitative aspects, in particular (dis)continuity and variability. Finally, the analysis of (dis)continuity and variability will be combined into a new approach to the analysis of quantitative growth patterns. In the second part of the chapter, this new approach to

continuity and discontinuity is applied to our own dataset of early child language (subjects Heleen, Jessica, Berend and Lisa, followed from roughly age 1;6 to age 2;6). Here, the results with regard to continuity versus discontinuity in the acquisition of prepositions are presented. The quantitative approach is defended by referring to the fact that, in the study of the acquisition of prepositions, the quantitative aspects are often underexposed. In the results and discussion sections, the question of whether the development of prepositions is either continuous or discontinuous is addressed and critically reviewed.

Chapter 5 introduces the second central topic of this thesis, which is ambiguity. It is known that the study of early child development is often hampered by problems of interpretability of behavioral categories. The chapter discusses problems with interpreting early child language and shows that the solutions for solving ambiguities in observations may have considerable effects on the developmental curves that result from the observations. The chapter proceeds by proposing a procedure to investigate the magnitude of the effect of decisions about how to categorize uninterpretable utterances. This so-called “what-if procedure” compares the effects of worst-case scenarios, i.e. scenarios where either all or none of the uninterpretable utterances are counted as real words. The illustration of such a worst-case scenario with the language data of one subject (subject Heleen, age 1;6 to 2;6) shows that the language development curves are relatively insensitive to how exactly uninterpretable utterances are scored.

Chapter 6 elaborates on ambiguity in language development and defines it as an intrinsic aspect of a developing language system. The phenomenon of ambiguity is also related to the question of observer reliability. In language acquisition, inter-transcriber agreement (over linguistic categories assigned to recorded utterances) is conceived as a measure of observer reliability. It is argued that the proportion of agreement over disagreement is not merely a reflection of observer errors or noisy data, but can be a reflection of the genuine ambiguity of early speech. Disagreement arises from the fact that the child is still building linguistic categories, and therefore, from the fact that the language is truly –intrinsically– ambiguous. This ambiguity can be quantified by applying concepts from fuzzy logic, which is demonstrated in a case study (subjects Lisa and Berend, age 2;0). After presenting an index of agreement and a Monte-Carlo procedure for calculating the probability of chance agreement, an index of ambiguity is introduced, based on the fuzzy logic notion of degree-of-membership.

Finally, chapter 7 summarizes the findings and discussions of the previous chapters and focuses on describing how the different themes (intra-individual variability, ambiguity and discontinuity) are intertwined through dynamic systems theory.

